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(71) Applicant: GUARDIAN INDUSTRIES CORP. [US/US]; 2300 Harmon Road, Auburn Hills, MI 48326-1714 (US).

(72) Inventor: LAIRD, Ronald, E.; 3540 Lexington Circle, Dexter, MI 48130 (US).

(74) Agent: RHOA, Joseph, A.; Nixon & Vanderhye P.C., Suite 800, 1100 North Glebe Road, Arlington, VA 22201-4714 (US).

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(54) Title: COATED ARTICLE WITH HIGH VISIBLE TRANSMISSION AND LOW EMISSIVITY

(57) Abstract: A coated article that can be used in applications such as insulating glass (IG) units, so that resulting IG units can achieve high visible transmission of at least 70% (e.g., when using clear glass substrates from 1.0 to 3.5 mm thick), combined with at least one of: (a) SHGC no greater than about 0.45, more preferably no greater than about 0.40; (b) SC no greater than about 0.49, more preferably no greater than about 0.46; (c) chemical and/or mechanical durability; (d) neutral transmissive color such that transmissive a* is from -5.0 to 0 (more preferably from -3.5 to -1.5), and transmissive b* is from -2.0 to 4.0 (more preferably from 1.0 to 3.0); and (e) neutral reflective color from the exterior of the IG unit (i.e., R_g/R_{out}) such that reflective a* is from -3.0 to 2.0 (more preferably from -2.0 to 0.5), and reflective b* is from -5.0 to 1.0 (more preferably from -4.0 to -1.0). In certain example non-limiting embodiments, coated articles herein comprise: substrate/TiO_x/ZnO_x/Ag/$NiCrO_x$/SnO_x/ZnO_x/Ag/$NiCrO_x$/SnO_x/Si_xN_y.

TITLE OF THE INVENTION

COATED ARTICLE WITH HIGH VISIBLE TRANSMISSION AND LOW EMISSIVITY

[0001] This invention relates to a coated article, and a method of making the same. In particular, this invention relates to a coated article having high visible transmission (e.g., absent tempering, heat bending, or other significant heat treatment), neutral color (transmissive and/or reflective), durability (mechanical and/or chemical), and/or low emissivity (low-E) characteristics, and a method of making the same.

BACKGROUND OF THE INVENTION

[0002] Coated articles are known in the art. For example, see U.S. Patent No. 5,800,933 to Hartig (the '933 patent). The '933 patent discloses, *inter alia*, a layer-stack of: glass substate/TiO_2/Si_3N_4/NiCr/Ag/NiCr/Si_3N_4. In columns 22-25 of the '933 patent, it can be seen from non-heat-treatable Example A that the resulting insulating glass (IG) unit used 2.3 mm glass sheets and had a visible transmission of 69.5%, a shading coefficient (SC) of 0.48, and thus a solar heat gain coefficient (SHGC) of about 0.418 (i.e., SC = SHGC/0.87). Even using these thin clear glass sheets (2.3 mm thick), the IG unit was still not able to achieve a visible transmission of at least 70%; this is unfortunate in certain non-limiting situations. Moreover, it would sometimes be desirable to have a SC and/or SHGC that was lower than those listed above, for solar management reasons that will be appreciated by those skilled in the art.

[0003] It will be appreciated by those skilled in the art that there exists a need in the art for a coated article that can be used in monolithic applications and/or applications such as IG units, so that resulting IG units can achieve high visible transmission (e.g., visible transmission of at least 70%) combined with one or more of (a) SHGC no greater than about 0.45, more preferably no greater than about 0.40; (b) SC no greater than about 0.49, more preferably no greater than about 0.46; (c) chemical and/or mechanical durability; (d) neutral transmissive color such that

transmissive a* is from –5.0 to 0 (more preferably from –3.5 to –1.5), and transmissive b* is from –2.0 to 4.0 (more preferably from 1.0 to 3.0); and (e) neutral reflective color from the exterior of the IG unit (i.e., Rg/R_{out}) such that reflective a* is from –3.0 to 2.0 (more preferably from –2.0 to 0.5), and reflective b* is from –5.0 to 1.0 (more preferably from –4.0 to –1.0).

BRIEF SUMMARY OF THE INVENTION

[0004] An object of this invention is to provide a coated article that can be used in applications such as insulating glass (IG) units, so that resulting IG units can achieve high visible transmission of at least 70% (e.g., when using clear glass substrates from 1.0 to 3.5 mm thick), combined with at least one of: (a) SHGC no greater than about 0.45, more preferably no greater than about 0.40; (b) SC no greater than about 0.49, more preferably no greater than about 0.46; (c) chemical and/or mechanical durability; (d) neutral transmissive color such that transmissive a* is from –5.0 to 0 (more preferably from –3.5 to –1.5), and transmissive b* is from –2.0 to 4.0 (more preferably from 1 to 3.0); and (e) neutral reflective color from the exterior of the IG unit (i.e., Rg/R_{out}) such that reflective a* is from –3.0 to 2.0 (more preferably from –2.0 to 0.5), and reflective b* is from –5.0 to 1.0 (more preferably from –4.0 to –1.0).

[0005] Another object of this invention is to provide an article having a layer stack comprising:
substrate/TiO_x/ZnO_x/Ag/$NiCrO_x$/SnO_x/ZnO_x/Ag/$NiCrO_x$/SnO_x/Si_xN_y. In certain example non-limiting embodiments of this invention, such a layer stack may enable one or more of the above-listed objects and/or needs to be met.

[0006] Another object of this invention is to fulfill one or more of the above-listed objects and/or needs.

[0007] In certain example non-limiting embodiments of this invention, one or more of the above-listed objects and/or needs is/are satisfied by providing a coated article comprising:

a substrate;

a first dielectric layer supported by the substrate;

a lower contact layer comprising zinc oxide;

an infrared (IR) reflecting layer comprising silver;

an upper contact layer comprising at least one of an oxide of nickel, an oxide of chromium, and nickel chrome oxide; and

wherein the IR reflecting layer comprising silver is located between and in contact with the lower and upper contact layers.

[0008] In other example embodiments of this invention, one or more of the above-listed needs and/or objects is/are satisfied by providing an insulating glass (IG) window unit comprising:

first and second substrates spaced from one another,

a coating supported by the first substrate, the coating including first and second IR reflecting layers, each of the IR reflecting layers being sandwiched between and contacting a respective pair of contact layers;

wherein the coating has a sheet resistance (R_s) no greater than 3.5 ohms/square; and

wherein the IG window unit has a visible transmission of at least 70%, a solar heat gain coefficient (SHGC) no greater than 0.45, and outside reflective color characterized by $a^*_{outside\ reflective}$ from –3.0 to 2.0 and $b^*_{outside\ reflective}$ from –5.0 to 1.0.

[0009] In other example embodiments of this invention, one or more of the above-listed objects and/or needs is/are satisfied by providing a coated article comprising:

a coating or layer system supported by a glass substrate, the coating or layer system comprising from the glass substrate outwardly:

a) a titanium oxide inclusive layer;

b) a zinc oxide inclusive contact layer;

c) a silver inclusive layer;

d) a nickel chrome oxide inclusive layer;

e) a tin oxide inclusive layer;

f) a zinc oxide inclusive layer;

g) a silver inclusive layer;

h) a nickel chrome oxide inclusive layer; and

i) a silicon nitride inclusive layer;

wherein the coated article has a visible transmission of at least about 70% and the coating or layer system has a sheet resistance (R_s) of no greater than 5.0 ohms/square.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] FIGURE 1 is a cross sectional view of a coated article according to an example embodiment of this invention.

[0011] FIGURE 2 is a cross sectional view of an insulating glass (IG) unit utilizing the coated article of Fig. 1 (or alternatively, the coated article of Fig. 3 or Fig. 4) according to an example embodiment of this invention.

[0012] FIGURE 3 is a cross sectional view of a coated article according to another example embodiment of this invention, similar to the Fig. 1 embodiment except that the tin oxide layer is not present.

[0013] FIGURE 4 is a cross sectional view of a coated article according to another example embodiment of this invention, illustrating that a diamond-like carbon (DLC) layer may be provided over top of any of the coatings or layer systems herein.

DETAILED DESCRIPTION OF EXAMPLE EMBODIMENTS OF THE INVENTION

[0014] Referring now more particularly to the accompanying drawings in which like reference numerals indicate like parts throughout the several views.

[0015] Certain embodiments of this invention provide a low-E coating or layer system that may be used in applications such as insulating glass (IG) window units, vehicle windows, skylights, glass doors, and the like. Coated articles (e.g., monolithic or IG units) according to certain embodiments of this invention preferably have high visible transmission of at least 70% (e.g., when using clear glass substrates from 1.0

to 3.5 mm thick). In the example context of IG units, this high visible transmission is coupled with at least one of: (a) SHGC no greater than about 0.45, more preferably no greater than about 0.40; (b) SC no greater than about 0.49, more preferably no greater than about 0.46; (c) chemical and/or mechanical durability; (d) neutral transmissive color such that transmissive a* is from –5.0 to 0 (more preferably from –3.5 to –1.5), and transmissive b* is from –2.0 to 4.0 (more preferably from 1.0 to 3.0); and (e) neutral reflective color from the exterior of the IG unit (i.e., Rg/R_{out}) such that reflective a* (i.e., a^*_g) is from –3.0 to 2.0 (more preferably from –2.0 to 0.5), and reflective b* (i.e., b^*_g) is from –5.0 to 1.0 (more preferably from –4.0 to –1.0).

[0016] Figure 1 is a side cross sectional view of a coated article according to an example non-limiting embodiment of this invention. The coated article includes substrate 1 (e.g., clear, green, bronze, or blue-green glass substrate from about 1.0 to 10.0 mm thick, more preferably from about 1.0 mm to 3.5 mm thick), and coating (or layer system) 27 provided on the substrate 1 either directly or indirectly. The coating (or layer system) 27 includes: first dielectric anti-reflection layer 3, first lower contact layer 7 (which contacts layer 9), first conductive metallic infrared (IR) reflecting layer 9, first upper contact layer 11 (which contacts layer 9), second dielectric layer 13 (which may be deposited in one or multiple steps in different embodiments of this invention), second lower contact layer 17 (which contacts layer 19), second conductive metallic IR reflecting layer 19, second upper contact layer 21 (which contacts layer 19), third dielectric layer 23, and finally fourth protective dielectric layer 25. The "contact" layers 7, 11, 17 and 21 each contact at least one IR reflecting layer (e.g., Ag layer). The aforesaid layers 3-25 make up low-E (i.e., low emissivity) coating 27 which is provided on glass or plastic substrate 1.

[0017] In certain preferred embodiments of this invention, first dielectric layer 3 may be of or include titanium oxide (e.g., TiO_x where x is from 1.7 to 2.3, most preferably x is about 2.0). However, in other embodiments, layer 3 may be of or include silicon nitride (Si_xN_y where x/y may be about 0.75 (i.e., Si_3N_4), or alternatively x/y may be from about 0.76 to 1.5 in Si-rich embodiments), aluminum oxide, tin oxide, zinc oxide, BiO_x, SiZrN, or any other suitable dielectric material. Preferably, first dielectric layer 3 has an index of refraction "n" of at least 1.7, and

preferably from 2.0 to 2.7, and most preferably from 2.2 to 2.6. First dielectric layer 3 functions as an antireflection layer in certain embodiments of this invention.

[0018] Infrared (IR) reflecting layers 9 and 19 are preferably metallic and conductive, and may be made of or include silver (Ag), gold, or any other suitable IR reflecting material. However, metallic Ag is the material of choice for the IR reflecting layers 9 and 19 in certain example non-limiting embodiments of this invention. These IR reflecting layers help enable coating 27 to have low-E and/or good solar control characteristics.

[0019] The upper contact layers 11 and 21 (i.e., "upper" means the contact layers on top of the respective IR reflective layers 9, 19) are of or include nickel (Ni) oxide, chromium/chrome (Cr) oxide, or a nickel alloy oxide such as nickel chrome oxide ($NiCrO_x$), in preferred embodiments of this invention. The use of, for example, $NiCrO_x$ for/in these layers enables durability to be improved, compared to the use of certain other materials (e.g., compared to zinc oxide). $NiCrO_x$ layers 11 and/or 21 may be fully oxidized in certain embodiments of this invention (i.e., fully stoichiometric), or may be at least about 50% oxidized in other embodiments of this invention. While $NiCrO_x$ is a preferred material for upper contact layers 11 and 21, those skilled in the art will recognize that other materials may instead be used (e.g., oxides of Ni, oxides of Ni alloys, oxides of Cr, oxides of Cr alloys, $NiCrO_xN_y$, or other suitable material) for one or more of these layers in alternative embodiments of this invention. It is noted that upper contact layers 11 and/or 21 may or may not be continuous in different embodiments of this invention, depending upon their respective thickness(es).

[0020] When upper contact layers 11 and/or 21 comprise $NiCrO_x$ in certain embodiments, the Ni and Cr may be provided in different amounts, such as in the form of nichrome by weight about 80-90% Ni and 10-20% Cr. In other embodiments, sputtering targets used in sputtering layer(s) 11 and/or 21 may be 50/50 Ni/Cr, 60/40 Ni/Cr, 70/30 Ni/Cr, or any other suitable ratio. An exemplary sputtering target for depositing these layers includes not only SS-316 which consists essentially of 10% Ni and 90% other ingredients, mainly Fe and Cr, but potentially Haynes 214 alloy as well (e.g., see U.S. Patent No. 5,688,585). Upper contact layer(s) 11 and/or 21 (e.g., of or

including $NiCrO_x$) may or may not be oxidation graded in different embodiments of this invention. Oxidation grading means that the degree of oxidation in the layer(s) changes throughout the thickness of the layer(s) so that for example a contact layer may be graded so as to be less oxidized at the contact interface with the immediately adjacent IR reflecting layer than at a portion of the contact layer(s) further or more/most distant from the immediately adjacent IR reflecting layer.

[0021] The lower contact layers 7 and 17 ("lower" means the contact layers on the underneath side of the IR reflecting layers 9, 19) are of or include zinc oxide (e.g., ZnO_x, where x if from 0.6 to 1.2 in different embodiments, more preferably x is from 0.7 to 1.0) in preferred, but non-limiting, embodiments of this invention. For example, lower contact layer(s) 7 and/or 11 may consist essentially of zinc oxide in certain embodiments of this invention, while in other embodiments of this invention lower contact layer(s) 7 and/or 11 may include or consist essentially of $ZnAlO_x$, where x is set to a value such that the %Al (by weight) in the layer is from about 0-15%, more preferably from about 0-6%, and most preferably from about 1-4%. The use of these materials (e.g., ZnO_x, $ZnAlO_x$, or the like) for lower contact layer(s) 7 and/or 17 enables visible transmission of the resulting coated article to be increased (compared to if $NiCrO_x$ was used for these layers), enables sheet resistance R_s and/or emissivity to be reduced, and overall enables solar performance to be improved. In ZnO_x inclusive contact layer(s) 7 and/or 17, x may be set so that the layer is fully stoichiometric (e.g., ZnO), or alternatively may be set to a value from 0.4 to 0.99, more preferably from 0.7 to 0.99, and most preferably from 0.8 to 0.99 so that the layer(s) is more conductive (e.g., this can be done by reducing the amount of oxygen gas and increasing the amount of Ar gas used during a sputter coating process). Additionally, in certain embodiments of this invention, layer(s) 7 and/or 17 have an index of refraction of from 1.8 to 2.2, more preferably from about 1.9 to 2.1, so that for example layers 3 and 7 clearly represent separate and distinct films.

[0022] Surprisingly, it has been found that by using ZnO_x, $ZnAlO_x$, or the like for the lower contact layer(s) 7 and/or 17, while using $NiCrO_x$ for the upper contact layer(s) 11 and/or 21, the resulting coated article can achieve a combination of high visible transmission and reduced sheet resistance R_s, as well as acceptable durability

(mechanical and/or chemical). The highly durable $NiCrO_x$ is used for the upper contact layers 11 and/or 21 for durability purposes, while the solar controlling ZnO_x, $ZnAlO_x$, or the like is used for the lower contact layer(s) 7 and/or 17 to improve visible transmission and/or other solar characteristics. In other words, the $NiCrO_x$ provides good durability, especially when on top of the Ag layers, and the zinc oxide inclusive contact layer(s) enable high visible transmission to be combined with low sheet resistance R_s and/or good solar performance.

[0023] Second dielectric layer 13 acts as a coupling layer between the two halves of the coating 27, and is of or includes tin oxide (e.g., SnO_2 or some non-stoichiometric form thereof) in certain embodiments of this invention. However, other dielectric-materials may instead be used for layer 13, including but not limited to silicon nitride, titanium dioxide, niobium oxide, silicon oxynitride, zinc oxide, or the like.

[0024] Third and fourth dielectric layers 23 and 25 enable the environmental resistance of the coating 27 to be improved, and are also provided for color purposes. In certain example embodiments, dielectric layer 23 may be of or include tin oxide (e.g., SnO_2), although other materials may instead be used. Dielectric overcoat layer 25 may be of or include silicon nitride (e.g., Si_3N_4) in certain embodiments of this invention, although other materials may instead be used such as titanium dioxide, silicon oxynitride, tin oxide, zinc oxide, niobium oxide, or the like.

[0025] Other layer(s) below or above the illustrated coating 27 may also be provided. Thus, while the layer system or coating 27 is "on" or "supported by" substrate 1 (directly or indirectly), other layer(s) may be provided therebetween. Thus, for example, coating 27 of Fig. 1 may be considered "on" and "supported by" the substrate 1 even if other layer(s) are provided between layer 3 and substrate 1. Moreover, certain layers of coating 27 may be removed in certain embodiments, while others may be added in other embodiments of this invention without departing from the overall spirit of certain embodiments of this invention. For example, in the Fig. 3 embodiment of this invention, a coating 27 is provided which is similar to the coating of Fig. 1 except that the upper SnO_2 inclusive layer 23 is not present in the Fig. 3 embodiment.

[0026] Figure 2 illustrates the coating or layer system 27 being utilized on surface #2 of an IG window unit. Coatings 27 according to any embodiment herein may be used in IG units as shown in Fig. 2. In order to differentiate the "inside" of the IG unit from its "outside", the sun 29 is schematically presented on the outside. The IG unit includes outside glass pane or sheet (i.e., substrate 1 from Fig. 1) and inside glass pane or sheet 31. These two glass substrates (e.g. float glass 1-10 mm thick) are sealed at their peripheral edges by a conventional sealant and/or spacer 33 and may be provided with a conventional desiccant strip (not shown). The panes may then be retained in a conventional window or door retaining frame. By sealing the peripheral edges of the glass sheets and replacing the air in insulating space (or chamber) 30 with a gas such as argon, a typical, high insulating value IG unit is formed. Optionally, insulating space 30 may be at a pressure less than atmospheric pressure in certain alternative embodiments (with or without a gas in space 30), although this of course is not necessary in all embodiments. While the inner side of substrate 1 is provided with coating 27 in Fig. 2, this invention is not so limiting (e.g., coating 27 may instead be provided on the interior surface of substrate 31 in other embodiments of this invention).

[0027] Turning back to Fig. 1, while various thicknesses may be used consistent with one or more of the objects discussed herein, exemplary preferred thicknesses and example materials for the respective layers on the glass substrate 1 in the Fig. 1-2 embodiment are as follows:

[0028] **Table 1 (Example Materials/Thicknesses; Fig. 1 Embodiment)**

Layer	Preferred Range (Å)	More Preferred (Å)	Example (Å)
TiO_2 (layer 3)	0-700 Å	100-400 Å	200 Å
ZnO_x (layer 7)	25-200 Å	40-150 Å	90 Å
Ag (layer 9)	50-250 Å	80-200 Å	130 Å
$NiCrO_x$ (layer 11)	5-100 Å	15-60 Å	30 Å
SnO_2 (layer 13)	0-1,000 Å	500-900 Å	680 Å

ZnO_x (layer 17)	25-200 Å	40-150 Å	90 Å
Ag (layer 19)	50-250 Å	80-220 Å	168 Å
$NiCrO_x$ (layer 21)	5-100 Å	15-60 Å	30 Å
SnO_2 (layer 23)	0-500 Å	70-200 Å	125 Å
Si_3N_4 (layer 25)	0-500 Å	120-320 Å	220 Å

[0029] In certain exemplary embodiments of this invention, coating/layer systems 27 according to all embodiments above have the following low-E (low emissivity) characteristics set forth in Table 2 when provided in the context of an insulating glass (IG) window unit (see Fig. 2), absent any significant heat treatment such as tempering or heat bending (although heat treatment may be performed in other embodiments of this invention). It is noted that in Table 2 the term E_n means normal emissivity/emittance.

Table 2: Low-E Characteristics (no heat treatment)

Characteristic	General	More Preferred	Most Preferred
R_s (ohms/sq.):	<= 5.0	<= 3.5	<= 2.8
E_n:	<= 0.07	<= 0.04	<= 0.03

[0030] Moreover, coated articles including coatings 27 according to certain exemplary embodiments of this invention have the following solar characteristics (e.g., when the coating(s) is provided on a clear soda lime silica glass substrate 1 from 2.0 to 3.2 mm thick) in monolithic form. In Table 3 below, R_gY is visible reflection from the glass (g) side of the monolithic article, while R_fY is visible reflection from the side of the monolithic article on which film (f) (i.e., coating 27) is located.

Table 3: Monolithic Solar Characteristics

Characteristic	General	More Preferred
T_{vis} (or TY)(Ill. C, 2 deg.):	>= 70%	>= 75%
a^*_t (Ill. C, 2°):	-5.0 to 0.0	-4.0 to -1.5
b^*_t (Ill. C, 2°):	-4.0 to 4.0	1.0 to 3.0
R_gY (Ill. C, 2 deg.):	1 to 10%	3 to 6%
a^*_g (Ill. C, 2°):	-2.0 to 4.0	0.0 to 2.5
b^*_g (Ill. C, 2°):	-7.0 to 1.0	-5.0 to 0.0
R_fY (Ill. C, 2 deg.):	1 to 7%	1 to 5%
a^*_f (Ill. C, 2°):	-2.0 to 5.0	-0.5 to 3.0
b^*_f (Ill. C, 2°):	-9.0 to 1.0	-7.0 to -0.0
SHGC:	<= 0.49	<= 0.45
SC:	<= 0.56	<= 0.53
$T_{ultraviolet}$:	<= 0.41	<= 0.39
$T_{UV\ damage\ weighted}$:	<= 0.50	<= 0.48

[0031] Meanwhile, IG window units utilizing coatings 27 according to certain embodiments of this invention as shown in Fig. 2, have the following solar characteristics (e.g., where the coated glass substrate 1 is a clear soda lime silica glass substrate from 2 to 3.2 mm thick, and the other soda lime silica glass substrate 31 is clear and from 2 to 3.2 mm thick, absent any significant heat treatment). In Table 4 below, R_gY is visible reflection from the outside or exterior of the window (i.e., from where the sun is located in Fig. 2), and R_fY is visible reflection from the interior side (e.g., from within the building interior), and the a*, b* values under these respective reflection parameters also correspond to glass (g) side (i.e., from outside the window in Fig. 2) and film (f) side (i.e., from interior the window in Fig. 2).

Table 4: IG Unit Solar Characteristics

Characteristic	General	More Preferred
T_{vis} (or TY)(Ill. C, 2 deg.):	>= 69%	>= 70%
a^*_t (Ill. C, 2°):	-5.0 to 0.0	-3.5 to –1.5
b^*_t (Ill. C, 2°):	-2.0 to 4.0	1.0 to 3.0
R_gY (Ill. C, 2 deg.):	7 to 13%	9 to 11%
a^*_g (Ill. C, 2°):	-3.0 to 2.0	-2.0 to 0.5
b^*_g (Ill. C, 2°):	-5.0 to 1.0	-4.0 to –1.0
R_fY (Ill. C, 2 deg.):	7 to 14%	10 to 12%
a^*_f (Ill. C, 2°):	-3.0 to 2.0	-1.5 to 0.5
b^*_f (Ill. C, 2°):	-5.0 to 1.0	-4.0 to –1.5
SHGC:	<= 0.45	<= 0.40
SC:	<= 0.49	<= 0.46
U-value:	0.20 to 0.30	0.22 to 0.25
$T_{ultraviolet}$:	<= 0.36	<= 0.33
$T_{UV\ damage\ weighted}$:	<= 0.45	<= 0.39

[0032] It is noted that certain parameters can be tuned by adjusting layer thicknesses. For example, ultraviolet (UV) transmission ($T_{ultraviolet}$) can be reduced much further by adjusting dielectric thickness(es).

[0033] Figure 4 is a cross sectional view of a coated article according to yet another embodiment of this invention. The Fig. 4 embodiment is the same as the Fig. 1 embodiment, except that a layer(s) of diamond-like carbon (DLC) 26 is provided as an overcoat over top of (and optionally contacting) silicon nitride layer 25 (note: the Fig. 3 embodiment may be modified in a similar manner). DLC inclusive layer 26 may be hydrophobic, hydrophillic, or neither in different embodiments of this invention. For example and without limitation, any of the DLC inclusive layers described and/or illustrated in any of U.S. Pat. Nos. 6,261,693, 6,277,480, 6,280,834,

and/or 6,284,377 (all of which are hereby incorporated herein by reference) may be used as DLC inclusive layer 26 in different embodiments of this invention. DLC inclusive layer(s) 26 may be deposited on the substrate 1 as an overcoat via an ion beam deposition technique, or any other suitable deposition process.

EXAMPLES 1-2

[0034] The following example coated articles (Examples 1 and 2) were made in accordance with the Fig. 3 embodiment above (i.e., layer 23 was not present in the coating 27). In Example 1, the Fig. 3 coating or layer system 27 was sputtered onto a 3 mm thick clear soda lime silica glass substrate, using a known Leybold sputter coater (27 cathode system) at a line speed of 2.5 meters per minute. The sputter coater was set up/run as set forth below in Table 5 for Examples 1-2. Power (P) was measured in kW, current (I) in amps, and pressure (Press.) in mbar. The gas flow for Ar gas was measured in sccm, and included Ar gas flow from tuning gas segments. Thus, for example, for cathode 1, there was 350 sccm of main Ar gas flow, and all three tuning gas segments were each adjusted to output 50 sccm each of Ar gas for that cathode, which adds up to 500 sccm of Ar gas flow for cathode 1. For cathodes 1 and 2, oxygen gas flow was controlled and determined by setting all three set points (SP) for plasma emission monitor to 18 (this is what is meant by S.P. in Table 5 below). Note: the NiCr target(s) was 80/20 Ni/Cr. The coater set-up was the same for Examples 1 and 2, and monolithically the only difference between the examples being that in Example 1 the coating 27 was sputtered onto a 3 mm thick clear glass substrate, while in Example 2 the coating 27 was sputtered onto a 4 mm thick clear glass substrate.

[0035] **Table 5: Example Coater Set-up (Examples 1-2)**

Cathode	Target	Volts (V)	P (kW)	Ar (sccm)	O_2 (sccm)	N_2 (sccm)	Press. (mbar)	I(amp)
#1	Ti	704	75	500	SP	75	2.73×10^{-3}	90
#6	Ti	657	75	500	SP	75	4.87×10^{-3}	89
#7	ZnAl	600	22	350	530	0	4.83×10^{-3}	45

#9	Ag	438	5.5	150	0	0	2.35×10^{-3}	11.8
#10	NiCr	488	9	250	80	0	1.43×10^{-3}	18.7
#12	Sn	440	16	300	530	75	5.21×10^{-3}	34
#13	Sn	476	21	300	965	75	5.28×10^{-3}	50
#14	Sn	423	21	125	470	75	1.07×10^{-2}	50
#15	Sn	434	22.5	125	470	75	1.07×10^{-2}	50
#16	Sn	425	22	125	470	75	4.72×10^{-3}	55
#18	ZnAl	373	22	350	570	0	4.71×10^{-3}	72
#20	Ag	392	7.3	250	0	0	2.00×10^{-3}	18.8
#21	NiCr	495	8	250	75	0	1.99×10^{-3}	16.5
#25	Si	486	55	350	0	675	6.04×10^{-3}	134
#26	Si	444	55	350	0	1200	6.04×10^{-3}	140

[0036] Following the sputtering of the aforesaid coating 27 on substrate 1 (3mm thick in Example 1, and 4 mm thick in Example 2), the coated articles were measured monolithically (see Tables 6-7 below). Thereafter, the coated substrate including coating 27 and substrate 1 of each example was attached to another clear soda lime silica glass substrate 31 (the another substrate 31 was 2.3 mm thick in Example 1, and 3 mm thick in Example 2) in order to form an IG unit for each example as shown in Fig. 2. The IG units were also measured for solar properties.

The measured solar properties of the monolithic units and the IG units are set forth in Tables 6-7 below:

Table 6: Monolithic & IG Unit Solar Characteristics (Example 1)

Characteristic	Monolithic (Ex. 1)	IG Unit (Ex. 1)
T_{vis} (or TY)(Ill. C, 2 deg.):	77.8 %	71 %
a^*_t (Ill. C, 2°):	-2.9	-2.9
b^*_t (Ill. C, 2°):	2.0	2.0
R_gY (Ill. C, 2 deg.):	4.85 %	9.9 %
a^*_g (Ill. C, 2°):	0.85	-1.0
b^*_g (Ill. C, 2°):	-2.75	–2.0
R_fY (Ill. C, 2 deg.):	4 %	11.5 %
a^*_f (Ill. C, 2°):	2.5	-0.4
b^*_f (Ill. C, 2°):	-6.0	–3.0
SHGC:	0.448	0.394
SC:	0.52	0.45
$T_{ultraviolet}$:	0.38	0.32
$T_{UV\ damage\ weighted}$:	0.47	0.41

Table 7: Monolithic & IG Unit Solar Characteristics (Example 2)

Characteristic	Monolithic (Ex. 2)	IG Unit (Ex. 2)
T_{vis} (or TY)(Ill. C, 2 deg.):	76.2 %	69.5 %
a^*_t (Ill. C, 2°):	-1.8	-2.3
b^*_t (Ill. C, 2°):	2.05	2.09
R_gY (Ill. C, 2 deg.):	5 %	9.8 %

a^*_g (Ill. C, 2°):	1.65	-0.1
b^*_g (Ill. C, 2°):	-4.8	-2.4
R_fY (Ill. C, 2 deg.):	3.8 %	11.2 %
a^*_f (Ill. C, 2°):	0.6	-0.4
b^*_f (Ill. C, 2°):	-2.95	-1.1
SHGC:	0.448	0.397
SC:	0.52	0.46
$T_{ultraviolet}$:	0.38	0.32
$T_{UV\ damage\ weighted}$:	0.47	0.41

EXAMPLE 3

[0037] Example 3 is a theoretical example, and its characteristics are set forth below, including both coater set-up data and solar characteristic data. While Examples 1-2 dealt with the Fig. 2-3 embodiment, Example 3 relates to the Fig. 1-2 embodiment. Note that cathode #23 is to be used in the sputter coater to form tin oxide layer 23 as shown in Fig. 1.

[0038] **Table 8: Example Coater Set-up (Example 3)**

Cathode	Target	Volts (V)	P (kW)	Ar (sccm)	O_2 (sccm)	N_2 (sccm)	Press. (mbar)	I(amp)
#1	Ti	704	75	500	SP	75	2.73×10^{-3}	90
#6	Ti	657	75	500	SP	75	4.87×10^{-3}	89
#7	ZnAl	600	22	350	530	0	4.83×10^{-3}	45
#9	Ag	438	5.5	150	0	0	2.35×10^{-3}	11.8
#10	NiCr	488	9	250	80	0	1.43×10^{-3}	18.7

#12	Sn	440	16	300	530	75	$5.21x10^{-3}$	34
#13	Sn	476	21	300	965	75	$5.28x10^{-3}$	50
#14	Sn	423	21	125	470	75	$1.07x10^{-2}$	50
#15	Sn	434	22.5	125	470	75	$1.07x10^{-2}$	50
#16	Sn	425	22	125	470	75	$4.72x10^{-3}$	55
#18	ZnAl	373	22	350	570	0	$4.71x10^{-3}$	72
#20	Ag	392	7.3	250	0	0	$2.00x10^{-3}$	18.8
#21	NiCr	495	8	250	75	0	$1.99x10^{-3}$	16.5
#23	Sn	387	24	125	500	90	$2.78x10^{-3}$	60
#25	Si	486	35	350	0	675	$6.04x10^{-3}$	72
#26	Si	444	35	350	0	1200	$6.04x10^{-3}$	79

[0039] Following the sputtering of the aforesaid coating 27 on 2.3 mm thick substrate 1, the coated article is theoretically measured monolithically. Thereafter, the coated substrate including coating 27 and substrate 1 is to be attached to another clear soda lime silica 2.3 mm thick glass substrate 31 in order to form an IG unit for Example 3. Solar properties are as follows:

Table 9: Monolithic & IG Unit Solar Characteristics (Example 3)

Characteristic	Monolithic (Ex. 3)	IG Unit (Ex. 3)
T_{vis} (or TY)(Ill. C, 2 deg.):	77 %	70 %
a^*_t (Ill. C, 2°):	-3.25	-2.5
b^*_t (Ill. C, 2°):	2.0	2.0
R_gY (Ill. C, 2 deg.):	5 %	10 %

a^*_g (Ill. C, 2°):	1.0	-0.5
b^*_g (Ill. C, 2°):	-3.0	-2.0
R_fY (Ill. C, 2 deg.):	4 %	11.5 %
a^*_f (Ill. C, 2°):	1.5	-0.5
b^*_f (Ill. C, 2°):	-4.0	-2.5

[0040] Certain terms are prevalently used in the glass coating art, particularly when defining the properties and solar management characteristics of coated glass. Such terms are used herein in accordance with their well known meaning. For example, as used herein:

[0041] Intensity of reflected visible wavelength light, i.e. "reflectance" is defined by its percentage and is reported as R_xY or R_x (i.e. the Y value cited below in ASTM E-308-85), wherein "X" is either "G" for glass side or "F" for film side. "Glass side" (e.g. "G") means, as viewed from the side of the glass substrate opposite that on which the coating resides, while "film side" (i.e. "F") means, as viewed from the side of the glass substrate on which the coating resides.

[0042] Color characteristics are measured and reported herein using the CIE LAB a*, b* coordinates and scale (i.e. the CIE a*b* diagram, Ill. CIE-C, 2 degree observer). Other similar coordinates may be equivalently used such as by the subscript "h" to signify the conventional use of the Hunter Lab Scale, or Ill. CIE-C, 10^0 observer, or the CIE LUV u*v* coordinates. These scales are defined herein according to ASTM D-2244-93 "Standard Test Method for Calculation of Color Differences From Instrumentally Measured Color Coordinates" 9/15/93 as augmented by ASTM E-308-85, Annual Book of ASTM Standards, Vol. 06.01 "Standard Method for Computing the Colors of Objects by 10 Using the CIE System" and/or as reported in IES LIGHTING HANDBOOK 1981 Reference Volume.

[0043] The terms "emittance" and "transmittance" are well understood in the art and are used herein according to their well known meaning. Thus, for example, the term "transmittance" herein means solar transmittance, which is made up of

visible light transmittance (TY), infrared radiation transmittance, and ultraviolet radiation transmittance. Total solar energy transmittance (TS) is then usually characterized as a weighted average of these other values. With respect to these transmittances, visible transmittance, as reported herein, is characterized by the standard CIE Illuminant C, 2 degree observer, technique at 380 - 720 nm; near-infrared is 720 - 2500 nm; ultraviolet is 300 - 800 nm; and total solar is 300 - 2500 nm. For purposes of emittance, however, a particular infrared range (i.e. 2,500 - 40,000 nm) is employed.

[0044] Visible transmittance can be measured using known, conventional techniques. For example, by using a spectrophotometer, such as a Perkin Elmer Lambda 900 or Hitachi U4001, a spectral curve of transmission is obtained. Visible transmission is then calculated using the aforesaid ASTM 308/2244-93 methodology. A lesser number of wavelength points may be employed than prescribed, if desired. Another technique for measuring visible transmittance is to employ a spectrometer such as a commercially available Spectrogard spectrophotometer manufactured by Pacific Scientific Corporation. This device measures and reports visible transmittance directly. As reported and measured herein, visible transmittance (i.e. the Y value in the CIE tristimulus system, ASTM E-308-85) uses the Ill. C.,2 degree observer.

[0045] "Emittance" (E) is a measure, or characteristic of both absorption and reflectance of light at given wavelengths. When transmittance is zero, which is approximately the case for float glass with wavelengths longer than 2500 nm, the emittance may be represented by the formula:

$$E = 1 - \text{Reflectance}_{\text{film}}$$

[0046] For architectural purposes, emittance values become quite important in the so-called "mid-range", sometimes also called the "far range" of the infrared spectrum, i.e. about 2,500 - 40,000 nm., for example, as specified by the WINDOW 4.1 program, LBL-35298 (1994) by Lawrence Berkeley Laboratories, as referenced below. The term "emittance" as used herein, is thus used to refer to emittance values measured in this infrared range as specified by ASTM Standard E 1585-93 for measuring infrared energy to calculate emittance, entitled "Standard Test Method for Measuring and Calculating Emittance of Architectural Flat Glass Products Using

Radiometric Measurements". This Standard, and its provisions, are incorporated herein by reference. In this Standard, emittance is reported as hemispherical emittance/emissivity (E_h) and normal emittance/emissivity (E_n).

[0047] The actual accumulation of data for measurement of such emittance values is conventional and may be done by using, for example, a Beckman Model 4260 spectrophotometer with "VW" attachment (Beckman Scientific Inst. Corp.). This spectrophotometer measures reflectance versus wavelength, and from this, emittance is calculated using the aforesaid ASTM E 1585-93 which has been incorporated herein by reference.

[0048] Another term employed herein is "sheet resistance". Sheet resistance (R_s) is a well known term in the art and is used herein in accordance with its well known meaning. It is here reported in ohms per square units. Generally speaking, this term refers to the resistance in ohms for any square of a layer system on a glass substrate to an electric current passed through the layer system. Sheet resistance is an indication of how well the layer or layer system is reflecting infrared energy, and is thus often used along with emittance as a measure of this characteristic. "Sheet resistance" may for example be conveniently measured by using a 4-point probe ohmmeter, such as a dispensable 4-point resistivity probe with a Magnetron Instruments Corp. head, Model M-800 produced by Signatone Corp. of Santa Clara, California.

[0049] "Chemical durability" or "chemically durable" is used herein synonymously with the term of art "chemically resistant" or "chemical stability". Chemical durability is determined by boiling a 2" x 5" sample of a coated glass substrate in about 500 cc of 5% HCl for one hour (i.e. at about 220^{0}F). The sample is deemed to pass this test (and thus the layer system is "chemically resistant" or is deemed to be "chemically durable" or to have "chemical durability") if the sample's layer system shows no visible discoloration or visible peeling, and no pinholes greater than about 0.003" in diameter after this one hour boil.

[0050] "Mechanical durabi lility" as used herein is defined by the following tests. The test uses a Pacific Scientific Abrasion Tester (or equivalent) wherein a 2"x4"x1" nylon brush is cyclically passed over the layer system in 500 cycles

employing 150 gm of weight, applied to a 6"x17" sample. In this test, if no substantial, noticeable scratches appear when viewed with the naked eye under visible light, the test is deemed passed, and the article is said to be "mechanically durable" or to have "mechanical durability".

[0051] The terms "heat treatment" and "heat treating" as used herein mean heating the article to a temperature sufficient to enabling thermal tempering, bending, or heat strengthening of the glass inclusive article. This definition includes, for example, heating a coated article to a temperature of at least about 1100 degrees F (e.g., to a temperature of from about 550 degrees C to 900 degrees C) for a sufficient period to enable tempering.

[0052] The term "U-value" or "U-Factor" (synonymous with "thermal transmittance") is a term well understood in the art and is used herein according to this well known meaning. "U-value" herein is reported in terms of BTU/hr/ft^2/degrees F, and may be determined according to the guarded hot box method as reported in, and according to ASTM designation: C1199-91.

[0053] The term "shading coefficient" (SC) is a term well understood in the art and is used herein according to its well known meaning. It is determined according to ASHRAE Standard 142 "Standard Method for Determining and Expressing the Heat Transfer and Total Optical Properties of Fenestration Products" by ASHRAE Standards Project Committee, SPC 142, September 1995. SC may be obtained by dividing solar heat gain coefficient (SHGC) by about 0.87. Thus, the following formula may be used: SC=SHGC/0.87.

[0054] While the invention has been described in connection with what is presently considered to be the most practical and preferred embodiment, it is to be understood that the invention is not to be limited to the disclosed embodiment, but on the contrary, is intended to cover various modifications and equivalent arrangements included within the spirit and scope of the appended claims.

CLAIMS

1. A coated article comprising:

a coating or layer system supported by a glass substrate, the coating or layer system comprising from the glass substrate outwardly:

a) a titanium oxide inclusive layer;

b) a zinc oxide inclusive contact layer;

c) a silver inclusive layer;

d) a nickel chrome oxide inclusive layer;

e) a tin oxide inclusive layer;

f) a zinc oxide inclusive layer;

g) a silver inclusive layer;

h) a nickel chrome oxide inclusive layer; and

i) a silicon nitride inclusive layer;

wherein the coated article has a visible transmission of at least about 70% and the coating or layer system has a sheet resistance (R_s) of no greater than 5.0 ohms/square.

2. The coated article of claim 1, wherein the coated article comprises an insulating glass (IG) window unit.

3. The coated article of claim 1, further comprising a tin oxide inclusive layer located between layers h) and i), and wherein the layers have the following thicknesses:

a) titanium oxide inclusive layer:	100-400Å
b) zinc oxide inclusive contact layer:	40-150Å
c) silver inclusive layer:	50-250Å
d) nickel chrome oxide inclusive layer:	15-60Å
e) tin oxide inclusive layer:	<=1,000Å
f) zinc oxide inclusive layer:	40-150Å
g) silver inclusive layer:	50-250Å
h) nickel chrome oxide inclusive layer:	15-60Å

i) silicon nitride inclusive layer: <=500Å.

4. The coated article of claim 1, wherein the coated article comprises an IG window unit and has the following characteristics:

a^*_t (transmissive):	-5.0 to 0.0
b^*_t (transmissive):	-2.0 to 4.0
R_gY (outside reflectance):	7 to 13%
a^*_g (outside reflective):	-3.0 to 2.0
b^*_g (outside reflective):	-5.0 to 1.0
SHGC:	<= 0.45
SC:	<= 0.49
$T_{ultraviolet}$:	<= 0.36.

5. The coated article of claim 4, wherein the coated article comprises an IG window unit and has the following characteristics:

a^*_t (transmissive):	-3.5 to 1.5
b^*_t (transmissive):	1.0 to 3.0
R_gY (outside reflectance):	9 to 11%
a^*_g (outside reflective):	-2.0 to 0.5
b^*_g (outside reflective):	-4.0 to -1.0
SHGC:	<= 0.40
SC:	<= 0.46
$T_{ultraviolet}$:	<= 0.33.

6. The coated article of claim 1, wherein at least one of the zinc oxide inclusive layers b) and f) comprises zinc-aluminum-oxide, and where the coated article further comprises a tin oxide inclusive layer located between layers h) and i).

7. A coated article comprising:

a substrate;

a first dielectric layer supported by the substrate;

a lower contact layer comprising zinc oxide;

an infrared (IR) reflecting layer comprising silver;

an upper contact layer comprising at least one of an oxide of nickel, an oxide of chromium, and nickel chrome oxide; and

wherein the IR reflecting layer comprising silver is located between and in contact with the lower and upper contact layers.

8. The coated article of claim 7, wherein the lower contact layer comprises zinc aluminum oxide.

9. The coated article of claim 7, wherein the coated article has a visible transmission of at least 70% and a sheet resistance (R_s) of no greater than 5.0 ohms/square.

10. The coated article of claim 7, wherein the coated article comprises an insulating glass (IG) window unit.

11. The coated article of claim 7, further comprising

a second dielectric layer provided over top of and in contact with the upper contact layer;

another lower contact layer comprising zinc oxide;

another infrared (IR) reflecting layer comprising silver which contacts the another lower contact layer;

another upper contact layer comprising nickel chrome oxide, the another IR reflecting layer being sandwiched between and contacting the another lower contact layer and the another upper contact layer; and

a third dielectric layer provided over top of and in contact with the another upper contact layer.

12. The coated article of claim 11, wherein the first dielectric layer comprises titanium oxide.

13. The coated article of claim 11, wherein the second dielectric layer comprises tin oxide.

14. The coated article of claim 11, wherein the third dielectric layer comprises one of silicon nitride and tin oxide, and wherein the coated article further comprises a diamond-like carbon (DLC) inclusive layer provided as an overcoat.

15. The coated article of claim 7, wherein the coated article comprises an IG window unit and has the following characteristics:

a^*_t (transmissive):	-5.0 to 0.0
b^*_t (transmissive):	-2.0 to 4.0
R_gY (outside reflectance):	7 to 13%
a^*_g (outside reflective):	-3.0 to 2.0
b^*_g (outside reflective):	-5.0 to 1.0
SHGC:	<= 0.45
SC:	<= 0.49
$T_{ultraviolet}$:	<= 0.36.

16. The coated article of claim 15, wherein the coated article comprises an IG window unit and has the following characteristics:

a^*_t (transmissive):	-3.5 to 1.5
b^*_t (transmissive):	1.0 to 3.0
R_gY (outside reflectance):	9 to 11%
a^*_g (outside reflective):	-2.0 to 0.5
b^*_g (outside reflective):	-4.0 to -1.0
SHGC:	<= 0.40
SC:	<= 0.46
$T_{ultraviolet}$:	<= 0.33.

17. An insulating glass (IG) window unit comprising:

first and second substrates spaced from one another,

a coating supported by the first substrate, the coating including first and second IR reflecting layers, each of the IR reflecting layers being sandwiched between and contacting a respective pair of contact layers;

wherein the coating has a sheet resistance (R_s) no greater than 3.5 ohms/square; and

wherein the IG window unit has a visible transmission of at least 70%, a solar heat gain coefficient (SHGC) no greater than 0.45, and outside reflective color characterized by $a^*_{outside\ reflective}$ from –3.0 to 2.0 and $b^*_{outside\ reflective}$ from –5.0 to 1.0.

18. The IG window unit of claim 17, wherein the IG window unit has a SHGC no greater than 0.40 and a shading coefficient (SC) no greater than 0.46.

19. The IG window unit c· ·laim 17, wherein the pair of contact layers sandwiching the first IR reflecting layer therebetween includes a lower contact layer and an upper contact layer, and wherein the first IR reflecting layer includes Ag, and

wherein the lower contact layer comprises zinc oxide and is located between the first IR reflecting layer and the substrate, and the upper contact layer comprises at least one of nickel oxide, chromium oxide, and nickel-chrome oxide.

20. The IG window unit of claim 19, wherein the lower contact layer comprises zinc aluminum oxide and the upper contact layer comprises $NiCrO_x$.

21. A coated article comprising:

a coating supported by a glass substrate, the coating comprising an infrared (IR) reflecting layer sandwiched between and contacting first and second contact layers; and

wherein the first contact layer includes zinc oxide and the second contact layer comprises at least one of nickel oxide, chromium oxide, and nickel-chrome oxide.

22. The coated article of claim 21, wherein the first contact layer comprises $ZnAlO_x$.

23. The coated article of claim 21, wherein the second contact layer comprises $NiCrO_x$.

24. The coated article of claim 21, wherein the coating is durable, and the coated article has a visible transmission of at least 70% and the coating has a sheet resistance (R_s) no greater than 3.5 ohms/square, and wherein the first contact layer is located between the IR reflecting layer and the glass substrate.

25. The coated article of claim 21, wherein the coated article comprises an IG window unit and has the following characteristics:

a^*_t (transmissive):	-5.0 to 0.0
b^*_t (transmissive):	-2.0 to 4.0
R_gY (outside reflectance):	7 to 13%
a^*_g (outside reflective):	-3.0 to 2.0
b^*_g (outside reflective):	-5.0 to 1.0
SHGC:	<= 0.45
SC:	<= 0.49
$T_{ultraviolet}$:	<= 0.36.

26. The coated article of claim 25, wherein the coated article has the following characteristics:

a^*_t (transmissive):	-3.5 to 1.5
b^*_t (transmissive):	1.0 to 3.0
R_gY (outside reflectance):	9 to 11%
a^*_g (outside reflective):	-2.0 to 0.5
b^*_g (outside reflective):	-4.0 to -1.0
SHGC:	<= 0.40
SC:	<= 0.46
$T_{ultraviolet}$:	<= 0.33.

27. A coated article comprising:

a coating or layer system supported by a glass substrate, the coating or layer system comprising from the glass substrate outwardly:

a) a dielectric layer(s);

b) a zinc oxide inclusive contact layer;

c) a silver inclusive layer;

d) a contact layer including at least one of nickel oxide and chrome oxide;

e) a dielectric layer(s);

f) a zinc oxide inclusive contact layer;

g) a silver inclusive layer;

h) a contact layer; and

i) a dielectric layer(s);

wherein the coated article has a visible transmission of at least about 70% and the coating or layer system has a sheet resistance (R_s) no greater than 5.0 ohms/square.

28. The coated article of claim 27, wherein the a) dielectric layer(s) comprises titanium oxide.

29. The coated article of claim 27, wherein the e) dielectric layer(s) comprises tin oxide, and wherein the contact layer d) comprises $NiCrO_x$.

30. The coated article of claim 27, wherein the dielectric layer(s) i) comprises at least one of silicon nitride and tin oxide.

31. The coated article of claim 27, wherein the contact layers d) and h) each comprises $NiCrO_x$.

32. The coated article of claim 27, wherein at least one of the zinc oxide inclusive contact layers b) and f) comprises $ZnAlO_x$.

33. The coated article of claim 27, wherein the coated article comprises an IG window unit.

34. The coated article of claim 27, further comprising a diamond-like carbon (DLC) inclusive layer provided over the dielectric layer(s) i).

35. A method of making a coated article, the method comprising:

providing a substrate;

sputtering a first dielectric layer onto the substrate;

sputtering a lower contact layer comprising zinc oxide onto the substrate over the first dielectric layer;

sputtering an infrared (IR) reflecting layer over the lower contact layer;

sputtering an upper contact layer comprising at least one of an oxide of nickel, an oxide of chromium, and nickel chrome oxide, onto the substrate over and in contact with the IR reflecting layer; and

sputtering at least one dielectric layer onto the substrate over the upper contact layer.

36. The method of claim 35, further comprising ion beam depositing a diamond-like carbon (DLC) inclusive layer onto the substrate over the at least one dielectric layer.

37. A coated article comprising:

a substrate;

a first dielectric layer supported by the substrate;

an infrared (IR) reflecting layer comprising silver;

an upper contact layer comprising at least one of an oxide of nickel, an oxide of chromium, and nickel chrome oxide;

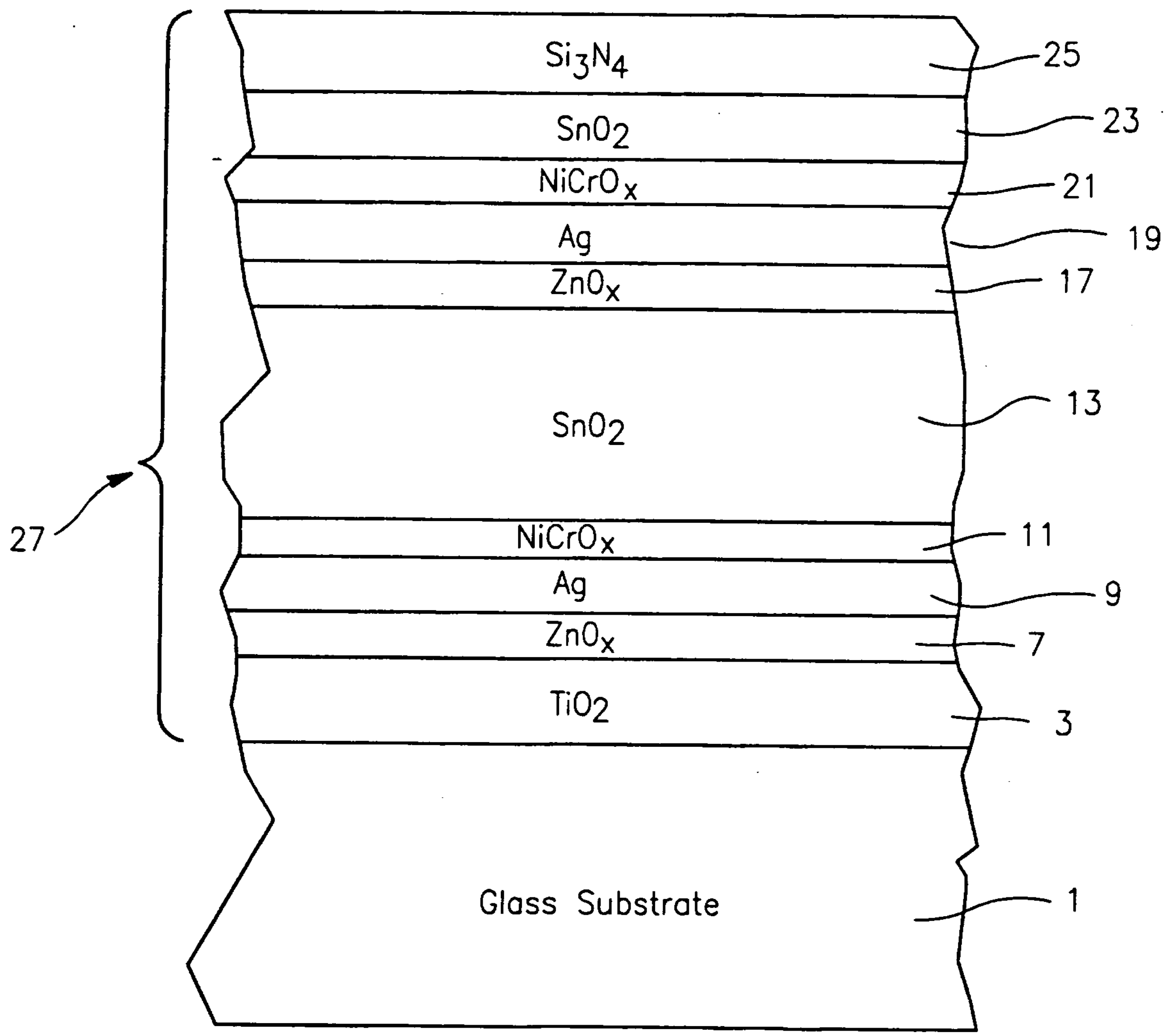
another dielectric layer comprising tin oxide provided over and in contact with the upper contact layer; and

another dielectric layer comprising silicon nitride provided over the another dielectric layer comprising tin oxide.

38. The coated article of claim 37, further comprising a lower contact layer comprising zinc aluminum oxide located below and in contact with the IR reflecting layer.

39. The coated article of claim 37, wherein the coated article has a visible transmission of at least 70% and coating thereon has a sheet resistance (R_s) of no greater than 5.0 ohms/square.

40. The coated article of claim 37, wherein the coated article comprises an insulating glass (IG) window unit.



Si3N4
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NiCrOx
Ag
ZnOx
SnO2
NiCrOx
Ag
ZnOx
TiO2
Glass Substrate
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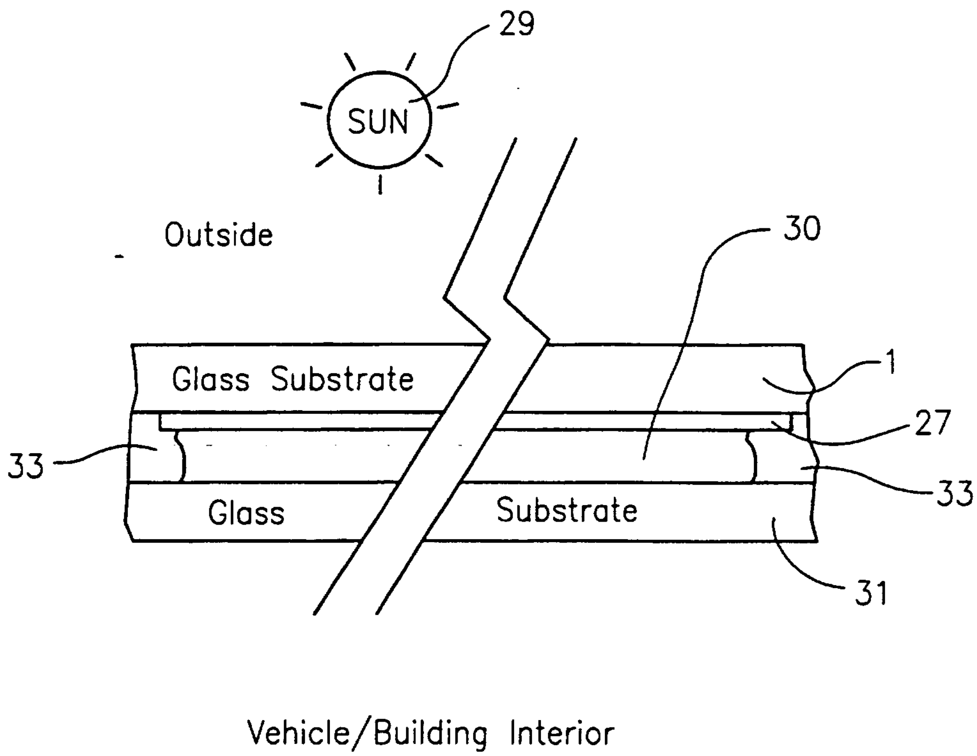
23
21
19
17
13
11
9
7
3
1
27

FIG. 1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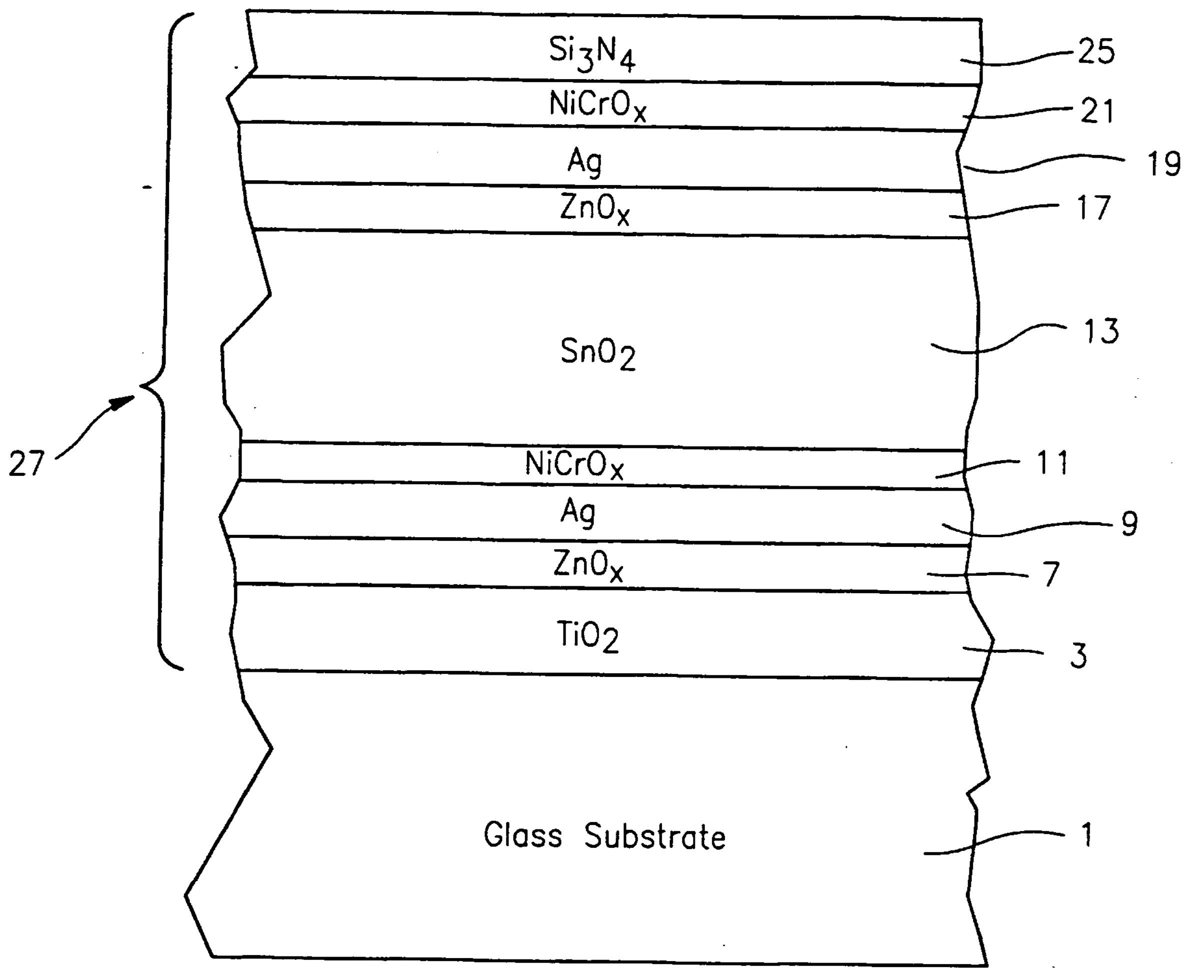
SUN
Outside
30
Glass Substrate
1
27
33
33
Glass
Substrate
31
Vehicle/Building Interior

FIG. 2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Ag
ZnOx
SnO2
NiCrOx
Ag
ZnOx
TiO2
Glass Substrate
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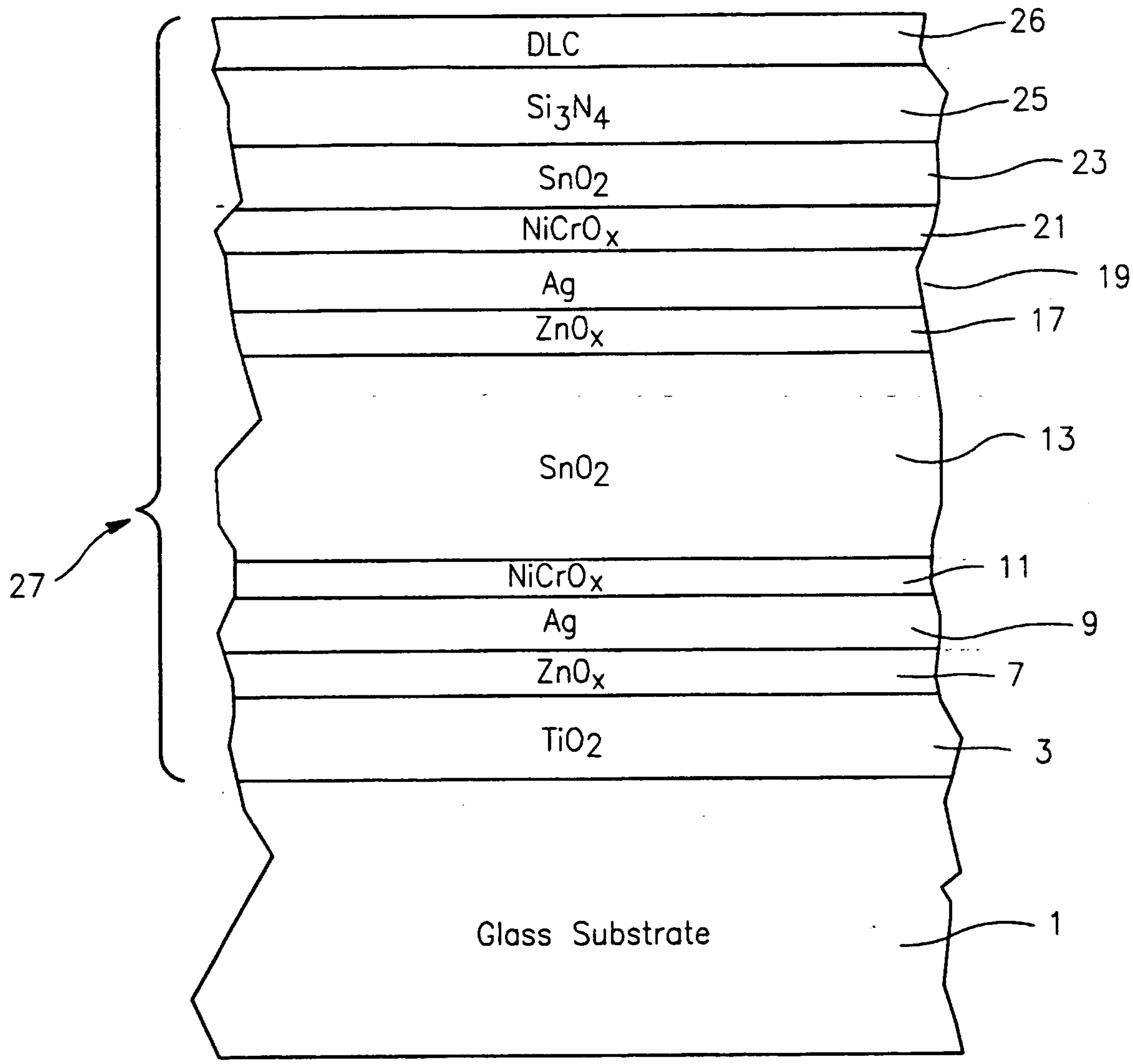
21
19
17
13
11
9
7
3
1
27

FIG. 3


DLC
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SnO_2
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Ag
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Ag
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TiO_2
Glass Substrate
26
25
23
21
19
17
13
11
9
7
3
1
27

FIG. 4

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 02/32909

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 C03C17/36

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 C03C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 962 115 A (ZMELTY ANTON ET AL) 5 October 1999 (1999-10-05) column 2, line 50 -column 3, line 32; claims	7,9-11, 13-19, 21,24-27
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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
11 March 2003	17/03/2003

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Van Bommel, L

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INTERNATIONAL SEARCH REPORT

International Application No
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